Role of aquatic resources in food and nutrition

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According to James Beard, a famous American author, and cook, "Food is our common ground, a universal experience". This is a powerful quote by him. The line means that food is the basic need in our lives for survival.

According to the Food and Agriculture Organization (FAO) and World Health Organization (WHO), foods may be cereals, vegetables, fruits, milk, eggs, fish and shellfish, meat, etc. [**1, 2**]. Nutrition tells us about the tiny conductors which harmonize our health. Nutrition focuses on how we can reduce the risk of diseases. Our food systems are focused on agriculture and livestock.

Aquatic resources are used as aquatic foods and nutrition for human beings. These can be harvested in various contexts and geographies to improve local and regional food security. However major commercial fish species tend to receive the main attention in aquatic foods from coastal and inland water bodies. These include indigenous fish species, crustaceans, seaweeds, oysters, etc.

The positive aspect of consuming "Aquatic foods" is that they contain micronutrients and essential fatty acids which are proven to be very effective for our body. Approximately 20 percent of people of 3.3 billion population intake their animal protein from fish.

However, Capture fisheries constitute the largest wild-food resource for people in low- and middle-income countries, providing a critical nutrient-rich food source. All the food system research, investments, and policies-related discussions will go in vain if the global food security initiatives do not pay heed to this matter. The diverse nature of aquatic food systems generates a plethora of employment opportunities along supply chains which include both primary activities and secondary post-harvest activities like fish processing, transportation, and retail. In the context of aquaculture, there's an array of activities, such as fish feed development and induced breeding parent stock to create genetically improved fish seed.

Throughout the world, in underdeveloped countries near about 800 million people depend on small-scale fisheries and aquaculture for their economy and livelihoods.

Aquatic Foods

Aquatic environments like ponds, pools, lakes, rivers, estuaries, coastal sea areas and oceans are the main resources of aquatic foods. These foods include several invertebrate and vertebrates including fishes.

The other name of aquatic foods are known as **blue foods**. Origin of blue food is water. Several aquatic animals of both invertebrates and vertebrates are included as the aquatic foods. Invertebrates animals like crabs, shrimps,, prawns and lobsters are the aquatic foods of phylum Arthropoda; cephalopods like octopus, squids, snails, mussels, clams and scallops as Mollusca, whereas fin fishes are included as vertebrates aquatic food. Fin fishes may be small pelagic fishes such as sardine, and herring, medium pelagic fishes like Mahi-Mahi, and Bonito, large pelagic fishes like swordfish, tuna, salmon, and trout, carps like Rohu, Catla, Cichilids as Tilapia and others as Cod fishes. [**2**]

All the aquatic foods can be obtained from capture and culture methods. Capturing can be done through natural resources. These can be done from inland waters like ponds, pools, lakes, rivers, and wetlands. Capture can be done from other water bodies like mangroves, estuaries, or near shore of the coastal areas and marine water bodies. Fish has an important contribution to a healthy diet for billions of people throughout the world. It is undervalued due to its monolithic category 'seafood or fish'.

However, according to the studies, it is well known that aquatic foods have rich nutrient value. Therefore, fish products are so popular today for people to consume for the development of health and body.

Collection of Aquatic Foods:

There are two ways through which we can collect these foods. These two ways are:

1. Capture Fishery and,
2. Culture Fishery

1. Capture Fishery: It is without any investment in nature. This collection involves harvested wild fish from the freshwater bodies and oceans.

2. Culture Fishery: It is the practice to construct a farm for aquatic fishes, both in freshwater and marine environmental conditions. This cultural method is dependent on money and investment of manpower i.e. labourers and other scientific requirements for its development.

Therefore, the production of Aquatic fish foods both Capture and Culture Fisheries is important view for humans. For this purpose, different employment facilities are involved in different ways for this fish food production. [**2, 3**]

Fish Production from Capture and Aquaculture

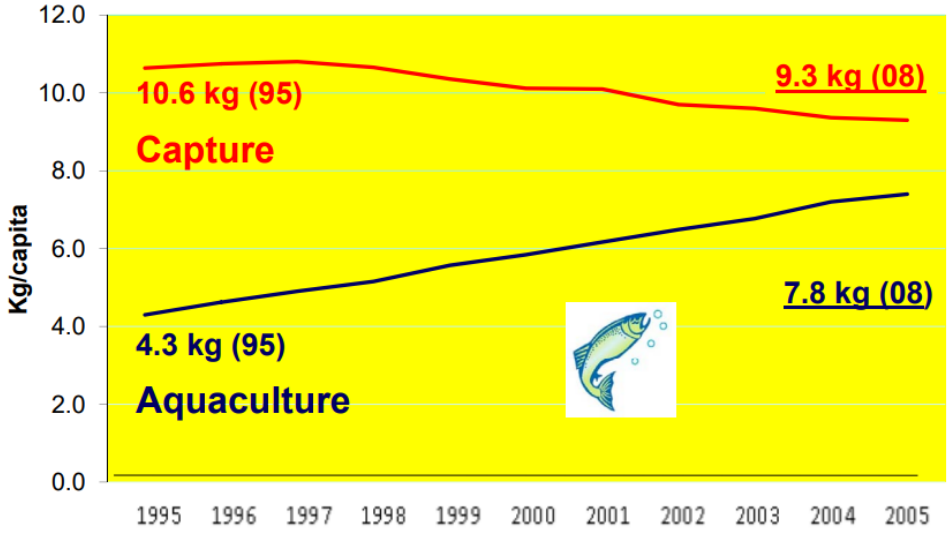


Figure 1: ***Per capita food fish supply from capture fisheries and aquaculture 1995 to 2008 (FAO, 2010)***

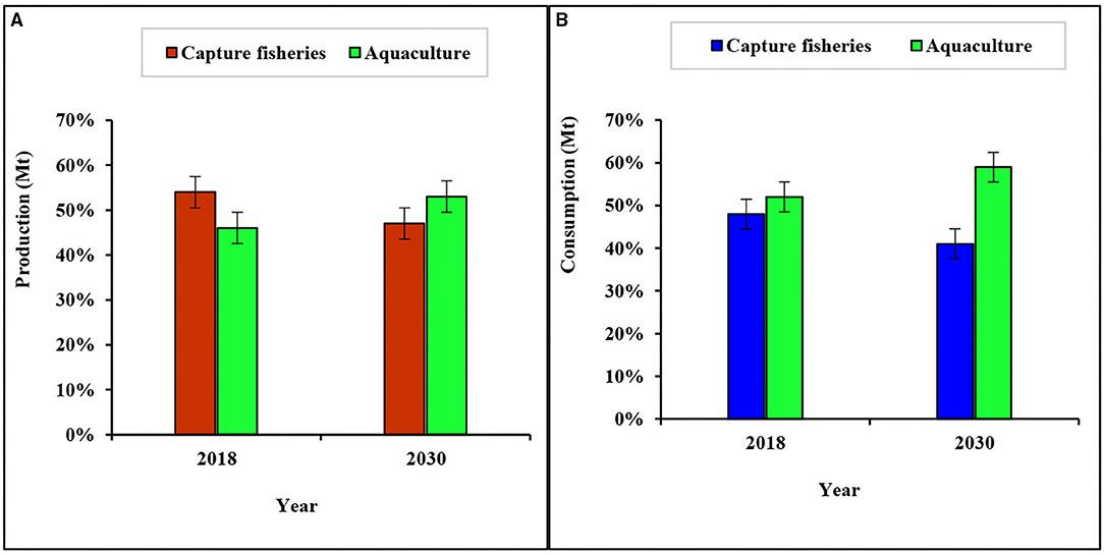


Figure 2: ***Global fish*** *(A)* ***production in 2018 and projected production in 2030, and*** *(B)* ***consumption in 2018 and projected consumption in 2030, from capture fisheries and aquaculture.*** **[Source: Adapted from FAO].**

The above two figures (adapted from the FAO report) help us to understand easily the production of fish food from captured and cultured methods. According To FAO, they are

highlighted on cultured fisheries rather than captured fish production. It is because of the level of biodiversity of natural resources.

Fish as Aquatic Food and Nutrition

Nutritional values of Fish

One ounce of boneless Fish has the following food value:

- 30 calories
- 0.7g of fat
- 5.5g of protein
- 0g of net carbohydrates.

Examples of Nutrition of Different Fishes

Comparing fish calories and nutrition data can be tricky because the way we prepare our fish can change its nutritional makeup significantly. The nutritional value of fish varies depending on the variety of fish.

Atlantic salmon contains

- 280 calories,
- 12.5g of fat(monounsaturated and polyunsaturated),
- 86mg sodium,
- 39.2g of protein.

Comparing other types of fish using the following guide based on **USDA** nutrition data.

Halibut (raw with skin):

- 116 calories,
- 3 grams fat,
- 0 grams carbohydrate,
- 20 grams of protein.

Tuna (yellow fin, fresh, raw):

- 109 calories,
- < one gram fat,
- 0 grams carbohydrate,
- 24 grams protein.

Cod (Atlantic, raw):

- 82 calories,
- 0.7 grams fat,
- 0 grams carbohydrate,
- 18 grams protein.

Mahi mahi (raw):

- 85 calories,
- 0.7 grams fat,
- 0 grams carbohydrate,
- 18.5 grams protein.

Ocean perch (Atlantic, raw):

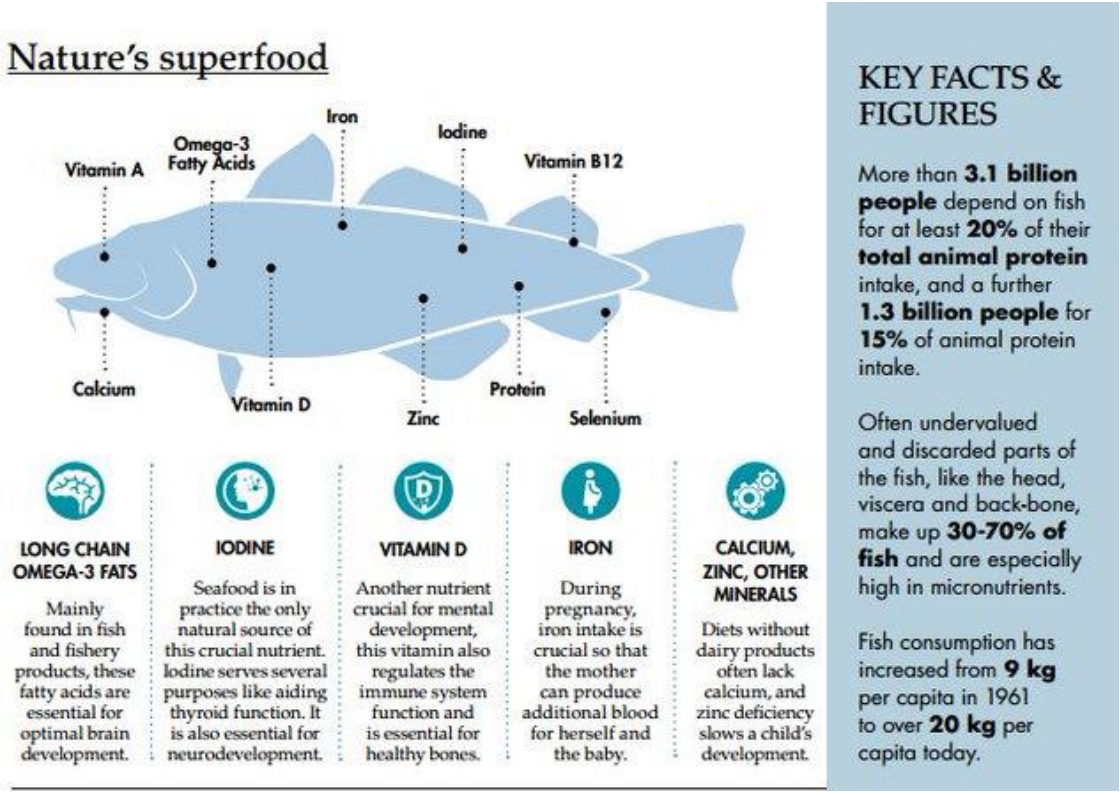
- 79 calories,
- 1.4 grams fat,
- 0 grams carbohydrate,
- 15 grams protein.

Components of Fish

Low fat, high quality protein, omega 3 fatty acids, D vitamin and riboflavin or B2 and also calcium, phosphorus and minerals like iron, iodine, zinc, potassium and magnesium are present in Fish.

Chemical Composition of Fish (overall)

- Protein content is **18-20%.**
- Fat content is in the range of **0.2 to 15%** mainly **PUFA.**
- Vitamins like A, D, E, K and some minerals such as **Calcium, Fluorine Iodine, Iron, Phosphorous, Selenium and Zinc. [4]**



[FAO- Fisheries and Aquaculture,2018]

Animal protein for human consumption in rural communities is easily available and cheap for fish food. Essential Amino Acids (EAA) and PUFAs (Polyunsaturated Fatty Acids) play an important role in the development of the brain in infants and adults due to these nutritional values in fish.

To fight against food insecurity and malnutrition, fish food plays a pivotal role.

Fatty fish is considered as one of the best fishes for losing weight but not all fatty fishes. A plethora of health wonders are provided by polyunsaturated fatty acids.

Fish that contain omega-3 fats help to reduce the risk of heart disease. Several studies show that the omega-3 fatty acids found in fish may help to reduce symptoms of rheumatoid arthritis and may even help to improve brain and eye health.

Those who do not eat fish can go for an alternate option such as taking supplements. However, several studies have still not got a good scientific conclusion.

Fishes are a major dietary source as complementary to our health and development. Major dietary sources of aquatic foods are supportive agents for our bodies and health. These aquatic foods mainly fish contain two polyunsaturated omega-3 fatty acids (PUFAs) which are docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA). Salmon and Mackerel are oily fishes that contain these PUFAs. Halibut and Blubber fish also contain these PUFAs.

PUFA has many important health benefits such as reducing cardiovascular diseases in adults. Pregnant mothers can consume these PUFA-rich fishes for healthy and ensured nutrition for the foetus.

Fish is also a nutritious food for the children's development and growth. This consumption of fish supports the children for their proper brain functioning, good eye-sight, and overall neurological function. [**5**]

Saturated and unsaturated fatty acids and PUFAs

Everybody should know about saturated, unsaturated fatty acids, and Polyunsaturated Fatty acids (PUFAs).

Saturated and unsaturated fatty acids are distinguished by the presence or absence of an intramolecular double bond. Animal oils can supply us with saturated fatty acids which can cause health risks to humans. But unsaturated fatty acids from vegetables retarded the risk of health for people and be beneficial. So, polyunsaturated fatty acids (PUFAs), mainly omega-3s are too much important for human health benefits.

There are several medications and able-to-pay foods on the market, and the number of products aimed at children has risen as well. However, since there is concern about indiscriminate and excessive PUFA intake, it is critical to understand the correct use of PUFAs. [**6**]

Difference between Healthy and Unhealthy fish:

We know very well that fish is a nutritious food and we can give benefits to our health. But, not all fishes are equally healthy and safe as our food and nutrition. Some fishes may contain high levels of heavy metals, mercury, and other contaminants. These elements can harm our health. So, we should choose fishes that are rich in omega-3 fatty acids and not other contaminants like mercury, cadmium, etc.

Now we will discuss healthy fishes.

These are:

1. Salmon
2. Sardine
3. Rainbow-trout

Some Unhealthy fishes are:

1. Swordfish
2. Tilefish and,
3. Shark.

Why Salmon is considered healthy?

The following characteristics determine that Salmon is good for our body. They are:

1. Contain Omega-3 fatty acids which help us to decrease inflammation, prevent blood clots, and also help us in lowering blood pressure.
2. This fish also contains protein, selenium, and Vitamin B complex. These are vital for metabolism and proper functioning of the nervous and immune systems.

Why Shark is considered unhealthy?

The following characteristics determine that sharks are not good for our bodies. They are:

1. The mercury content in them is significantly high which damages our nervous system.
2. The meat of sharks contains pesticides and dioxins which can cause cancer.

Therefore, we conclude by saying that the consumption of healthy fish food over unhealthy fish is food nutrition. [**7**]

Aquaculture as the source of fish food

High-quality animal protein can be obtained from fish that are easily digestible. So, aquaculture throughout the world is the fastest fish food-producing sector. In 2012, the production was about 90.4 million tons from global aquaculture out of which 66.6 million tons was fish food.

A variety of fish species can be cultured in aquaculture. These species of fish are carp, tilapia, shrimp, trout, mussels, etc.

Positive and negative impacts on the environment are brought by aquaculture depending upon the particular locations, scales, and types. Here it is mentioned about some of the positives of aquaculture:

1. Creating employment opportunities among the people living in villages and coastal areas.
2. Encouragement to recover endangered organisms including fishes has led to the conservation of biodiversity.
3. The availability of fish foods in developing nations has enhanced food credibility and security.

The disadvantages of aquaculture are:

1. The use of harmful organic chemicals in the water can cause pollution. This can affect the quality of water and the health of the cultured fish.
2. The introduction of non-native or genetically modified fish into the environment enhances the competition between native and introduced fishes for survival.

So, aquaculture should be practiced carefully and ethically. [**3**]

Technology in aquaculture: Boon to mankind

- Biotechnology and Genetic Engineering can help us to increase fish production in aquaculture. [**8**]
- Geographical information systems, remote sensing, drones, artificial intelligence, and block chain can monitor and control the activities of Fish culture. This will lead to the prevention of illegal fishing so that transparency and accountability can be ensured easily. [**9**]
- Technology in this field can enhance and modernize fish processing and preservation methods to reduce the post-harvest losses of fish products. Some processes are chilling, drying, canning, smoking, freezing, and vacuum packaging. [**10**]
- Technology in this field also ensures commercial growth for fish products trade through different e-commerce facilities such as mobile applications, traceability systems, and digital payments. These can increase the income of fish farmers without the intervention of intermediaries and transactional costs. [**11**]

Availability of fish food to poor people

- Aquaculture practice conserves natural resources and aquatic ecosystems preventing over-exploitation and pollution of biodiversity. [**12**]
- We should encourage the diversification of fish species, by promoting low costs, fast-growing, fish varieties and also encouraging the use of discarded fish.[**13**]
- The Governments of different countries, especially developing and underdeveloped countries should improve the quality and safety of fish food for human consumption by raising awareness and giving important guidelines and regulations.[**14**]

- They are improving the fish availability and accessibility for the poor by generating evidence and knowledge of fish food and their nutritional security and encouraging them to practice these innovations. [**15**]

Less Healthy Fish Options

We have discussed thoroughly the importance of fish food and its consumption benefits. But we have to also keep in mind that in some cases fish may be omitted from our balanced diet in our day-to-day life. For example, battered and fried fish are not fit for our bodies as they contain a serious amount of saturated fat.

Fast food centres hugely attract people as taste plays a major role. The calories are in a humongous amount which is not considered healthy for us.

Citing an example, breaded fish fillets contain approximately 350-400 calories 17-25 grams of fat, and up to 5 grams of sugar. [**16**]

Quality and Safety of fish is important before consumption

The protection of public health is determined by safety and proper quality of fish food. They can be contaminated by heavy metals which have high atomic mass that are five times greater compared to water. They are present in our Earth's crust.

Examples are Arsenic, Cadmium, Mercury, Lead, and Chromium which are toxic. These elements are a threat to mankind. Fish can accumulate these heavy metals especially Mercury through their gills and skin and hurt the people who consume them. [**17**]

Here, is a table that shows the names of some elements (heavy metals) which are considered toxic even in their low quantity. This is based on FAO report.

Heavy metal	Value (wet weight)	Value (dry weight)
Cr	0.15–1.0 ppm	0.65–4.35 ppm
Zn	30.0 ppm	130.43 ppm
Mn	1.00 ppm	4.35 ppm
Fe	100.00 ppm	434.78 ppm
Co	0.04–0.26 ppm	0.17–1.13 ppm
Cu	30.00 ppm	130.43 ppm
Se	1.00 ppm	4.35 ppm
Hg	0.50 ppm	2.17 ppm
Pb	0.50 ppm	2.17 ppm
Ni	80.00 ppm	347.82 ppm
As	1.00 ppm	4.35 ppm

TABLE: ***Recommended values of some heavy metal elements by the food and agriculture organization FAO.***

The following elements from fish food can affect the children and adults as follows:

Effect of Lead (Pb):

In children, low body mass and their behaviour, decrease IQ, Severe damage to brain and kidney functioning. [**18**]

Effect of Cadmium (Cd):

Cd has an adverse effect on males causing cancer. [**18**]

Effect of Arsenic (As):

Results in Heart diseases, hearing disability, cancer, and blood cell disorders. [**18**]

Effect of Mercury (Pb):

It mainly affects CNS in children and causes permanent damage.

Lead damages the kidneys, causes leukaemia, and neurological disorders due to the consumption of seafood in children. [**18**]

Effect of Chromium (Cr):

Serious misbalance in blood levels, cardiovascular diseases, and CNS. [**18**]

Then how can we stop this?

Simply, by conducting and monitoring the heavy metal accumulation in aquatic environments.

Effect of Biogenic Amines on fish food

Biogenic Amines (BAs) are a result of fish decomposition and making it fatal in nature. They are nitrogenous compounds. It is formed by decarboxylation of amino acids.

They include in fish food as **tyramine, tryptamine, histamine, putrescine, and cadaverine**.

In fish, BAs are associated with the formation of microorganisms with carboxylase activity. The consumption of these fishes, which produce histamine, causes scombroid poisoning.

Symptoms of consumption of Biogenic amines fishes

- Due to its effect, symptoms such as vomiting, nausea, diarrhoea, rashes, itching, and headache are seen in particular.
- Symptoms such as allergy, hypertension, and headache are caused due to BAs like tyramine, putrescine, and cadaverine.

How to control this adverse effect of BAs?

Simply awareness of the freshness of consumable fish food. So the following points should be remembered for fishes:

- Maintenance of fish food products
- Regular monitoring of these products. [**19,20,21**]

Summary

Studies have been done on the source of animal protein from aquatic foods, especially on fishes are considered as the key constituent of nutritious diets Aquatic foods are dependent on economic efficiency, production, resource management, environment, and climate. However, less attention is paid to people's health and nutrition. To build resilient food systems and healthy diets for all people, it is necessary to depend on available, affordable, and desired diets. In different parts of the world, where capture fisheries and food system development are poorly recognized and understood; where the diet quality is negligible mainly for children. To develop this situation use and consumption of fish should be popularized in those regions. Long-term effects on the health and growth of children under the age of 12 years should be provided fish in the diet as their fundamental nutritious food system. To reduce hunger and poverty the role of fish for human nutrition is important.

No doubt fish provide us with protein. Fish can be considered as an important source of animal protein. Consumption of fish will be increased day by day in the future. Due to the

increase in the number human population, the demand for high-quality healthy proteins is too much important for human health and nutrition. Important physiological role in the development and growth of foetuses, pregnant mothers, and new-born babies are possible to take polyunsaturated fatty acids (PUFAs). PUFAS are easily available only in fish. These fatty acids can also help us to develop against our auto-immune diseases, enhance normal blood flow, and decrease heart diseases, and chronic inflammation in human health. [**22, 23**].

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